Aerosol properties derived from airborne sky radiance and direct beam measurements in recent NASA and DoE field campaigns

J. Redemann[1], C.J. Flynn[2], Y. Shinozuka[3], P.B. Russell[1], M. Kacenelenbogen[3], M. Segal-Rosenheimer[3], J.M. Livingston[4], B. Schmid[2], S.E. Dunagan[1], R.R. Johnson[1], S. LeBlanc[5], S. Schmidt[6], P. Pilewskie[6], S. Song[6]

[1]*NASA Ames Research Center, Moffett Field, CA, USA*
[2]*Pacific Northwest National Laboratory,Richland, WA, USA*
[3]*BAERI/NASA Ames Research Center, Moffett Field, CA, USA*
[4]*SRI International, Menlo Park, CA, USA*
[5]*ORAU/NASA Ames Research Center, Moffett Field, CA, USA*
[6]*LASP, Univ of Colorado, Boulder, CO, USA*

The AERONET (AErosol RObotic NETwork) ground-based suite of sunphotometers provides measurements of spectral aerosol optical depth (AOD), precipitable water and spectral sky radiance, which can be inverted to retrieve aerosol microphysical properties that are critical to assessments of aerosol-climate interactions. Because of data quality criteria and sampling constraints, there are significant limitations to the temporal and spatial coverage of AERONET data and their representativeness for global aerosol conditions.

The 4STAR (Spectrometer for Sky-Scanning, Sun-Tracking Atmospheric Research) instrument, jointly developed by NASA Ames and PNNL with NASA Goddard collaboration, combines airborne sun tracking and AERONET-like sky scanning with spectroscopic detection. Being an airborne instrument, 4STAR has the potential to fill gaps in the AERONET data set. The 4STAR instrument operated successfully in the SEAC4RS [Studies of Emissions and Atmospheric Composition, Clouds and Climate Coupling by Regional Surveys] experiment in Aug./Sep. 2013 aboard the NASA DC-8 and in the DoE [Department of Energy]-sponsored TCAP [Two Column Aerosol Project, July 2012 & Feb. 2013] experiment aboard the DoE G-1 aircraft. 4STAR provided direct beam measurements of hyperspectral AOD, columnar trace gas retrievals (H2O, O3, NO2), and the first ever airborne hyperspectral sky radiance scans, which can be inverted to yield the same products as AERONET ground-based observations.

In this presentation, we provide an overview of the new 4STAR capabilities, with an emphasis on 26 high-quality sky radiance measurements carried out by 4STAR in SEAC4RS. We compare collocated 4STAR and AERONET sky radiances, as well as their retrievals of aerosol microphysical properties for a subset of the available case studies. We summarize the particle property and airmass characterization studies made possible by the combined 4STAR direct beam and sky radiance observations.